POSTERIOR CRUCIATE RETAINING VERSUS POSTERIOR CRUCIATE SACRIFICING TOTAL KNEE ARTHROPLASTY – A COMPARITIVE STUDY ON FUNCTIONAL OUTCOME

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CERTIFICATE

This is to certify that **Dr. M. ARUNMOZHIRAJAN,** Postgraduate student (2005-2008) in the department of orthopaedics, Government Kilpauk Medical College, Chennai has done this dissertation on **“POSTERIOR CRUCIATE RETAINING VERSUS POSTERIOR CRUCIATE SACRIFICING TOTAL KNEE ARTHROPLASTY – A COMPARITIVE STUDY ON FUNCTIONAL OUTCOME”** under my guidance and supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R. Medical University, Chennai for M.S. (Orthopaedics) degree examination to be held on March 2008.

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DECLARATION

I, **Dr. M. ARUNMOZHIRAJAN,** solemnly declare that dissertation titled **"POSTERIOR CRUCIATE RETAINING VERSUS POSTERIOR CRUCIATE SACRIFICING TOTAL KNEE ARTHROPLASTY – A COMPARITIVE STUDY ON FUNCTIONAL OUTCOME"** is a bonafide work done by me, at Government Kilpauk Medical College between 2005-2008, under the guidance and supervision of my respected unit **Chief Prof. Dr. K. SANKARALINGAM, D. Ortho., M.S. (Ortho.,) DNB Ortho**.,

This dissertation is submitted to Tamilnadu Dr. M.G.R. Medical University, towards partial fulfillment of regulation for the award of M.S. Degree (Branch – II) in Orthopaedic Surgery.

Place : Chennai

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CONTENTS

INTRODUCTION

Total knee arthroplasty has evolved over the past decades into a very much reliable surgical treatment for advanced arthritis of knee

Total knee replacement has been shown to restore patient function and relieve pain and deformity that results from knee arthrosis. The success of a total knee replacement is determined by many factors including pain relief, functional outcome, and range of motion, radiographic loosening or component revision.[1]

There have been numerous changes in the total condylar type of total knee arthroplasty during the past 20 years. These modifications include alterations in component geometry, understanding of the rotational alignment of the components, sizing options and modularity, accurate instrumentation for correcting deformity and improved cementation techniques.

The best knee replacement is one, which the kinematics of the normal knee is reproduced. Amongst several factors affecting the kinematics, variations in surface geometry and the retention or sacrificing the posterior cruciate ligament is considered especially important. Yet, there is no clear evidence of how best to deal with the posterior cruciate ligament at the time of knee replacement surgery. There are four options available to the surgeon. The first is to retain the ligament and to preserve as much as possible of the normal anatomy and function of the knee. Preservation of the ligament is thought to enhance stability, femoral rollback, mechanical advantage of the quadriceps muscle and proprioceptive properties.[2,3,4]

The second option is to excise the ligament in order to facilitate the correction of any fixed deformities.[5] This allows more accurate and reliable soft tissue balancing resulting in improved fixation of the components.

The third option is to substitute the ligament with a posterior stabilized tibial insert. These inserts have a central post, which can engage on a femoral cam during flexion, mimic femoral rollback and reproduce near normal kinematic profiles.[6] The central post may also allow some stability in the anteroposterior plane and act as a secondary stabilizer to a varus or valgus stress.[7, 9]

The fourth option is to release the ligament; this offers a compromise between preservation and excision.[8]

AIM OF THE STUDY

The aim of the study is to “prospectively compare the functional outcome between posterior cruciate ligament retaining and posterior cruciate ligament sacrificing total knee arthroplasty.” at the department of orthopaedics and traumatology, Government Kilpauk Medical College, Chennai between May 2005 and September 2007.

LITERATURE REVIEW

In the 1860s, Fergusson reported performing a resection arthroplasty of the knee for arthritis.[10] In 1863 Verneuil is thought to have performed the first interposition arthroplasty using joint capsule.[11] Other tissues were subsequently tried, including skin, muscle, fascia, fat, and even pig bladder.

The first artificial implants were tried in the 1940s as molds fitted to the femoral condyles following similar designs in the hip.[12,13] In the next decade, tibial replacement was also attempted, but both designs had problems with loosening and persistent pain. Combined femoral and tibial articular surface replacements appeared in the 1950s as simple hinges.[14] These implants failed to account for the complexities of knee motion and consequently had high failure rates from aseptic loosening. They were also associated with unacceptably high rates of postoperative infection.

In 1971, Gunston importantly recognized that the knee does not rotate on a single axis like a hinge, but rather the femoral condyles roll and glide on the tibia with multiple instant centers of rotation. His polycentric knee replacement had early success with its improved kinematics over hinged implants but was unsuccessful because of inadequate fixation of the prosthesis to bone.[15]

The highly conforming and constrained Geomedic knee arthroplasty introduced in 1973 at the Mayo Clinic ignored Gunston's work, and a kinematic conflict arose. Other designs followed, following Gunston’s principle in either attempting to reproduce normal knee kinematics or allowing a conforming articulation to govern knee motion.

The total condylar prosthesis was designed by Insall at the Hospital for Special Surgery in 1973. This prosthesis concentrated on mechanics and did not try to reproduce normal knee motion. Concurrent with the development of the cruciate-sacrificing total condylar prosthesis, the duo patellar prosthesis was developed as a derivative of duocondylar prosthesis in 1980. During the late 1980s and 1990s, patelofemoral complications became the primary cause for reoperation in total knee arthroplasty. Knee motion, which occurs about varying transverse axis, is a function of both the articular geometry and the ligamentous restraints.

The argument as to whether knee ligaments should be preserved or sacrificed continues to this day. Long-term follow-up studies do not show any significant differences, although gait appears to be less abnormal if ligaments are preserved, especially when walking up and down stairs. One theoretical way of incorporating normal kinematics and maximal conformity is with mobile tibial bearings. Current midterm follow-up studies of these prostheses have so far shown encouraging results.

Andriachhi TP in 1988 stated that the phenomenon of rollback of the femur on the tibia during flexion prevents the impingement of the femur on the posterior border of the tibia with flexion.[16] Freeman MAR and Railton GT in 1988 said that posterior articulation of the femur with the tibia in the replaced knee in flexion was mooted by shifting the axis of motion permanently posteriorly[17] as in the Freeman Samuelson knee.

Femoral rollback is defined as the posterior shift of the tibiofemoral contact areas.Walker and Hajek in 1972 investigated the load bearing area in cadaver knee and found the average contact areas for the lateral and medial condyles were 1.4 and 1.8cms.[18,19] In 1991 Thompson and colleagues used MRI to asses the behavior of the meniscus during flexion extension in cadaver knees.[20] Freeman and Railton[17], state that the section of the anterior cruciate ligament and retention of the posterior cruciate ligament destroys the normal mechanism of femoral rollback and roll forward.

In 1991 El Nahass[21] and associates used an electromagnetic device to track the motion of the knee in 25 normal volunteers and 25 total knee patients. Motion of the total knee patients was similar to that of the normal knees. For standing ,sitting ,and free-swing , the knee rotated internally by 5 to 10 degrees and the femur displaced posteriorly by 9 to 14 mm through a flexion range from 0 to 90 degrees. This result would imply that rollback does occur in the replaced knee with the posterior cruciate retention.

In 1993, Schoemaker and associates used a testing rig with 6 degrees of freedom to examine the motion of cadaveric knees with the anterior cruciate ligament intact, sectioned, and reconstructed. Normal rollback was seen in all these scenarios. Therefore, section of anterior cruciate ligament does not stop rollback. Rollback is therefore not solely dependent on an intact functioning anterior cruciate ligament. Whether or not rollback occurs in the knee without an anterior and posterior, cruciate ligament is not known.[22]

Soudry and colleagues showed that the retention of the posterior cruciate ligament stabilized femorotibial contact points close to the center of the surface using a series of tibial plastic designs. When the cruciate was sacrificed, they found that the contact points moved to the extreme anterior of the plastic, placing high compression anteriorly and the posterior component bone interface under tension. Such asymmetric loading predisposes to wear of the plastic and may predispose to mechanical failure of the component or cement bone interface.[23]

Ritter and colleagues in 1988 found that 30% of patients required posterior cruciate ligament balancing and that this was performed without sacrificing posterior stability of the knee. In summary, vast majority of the total knee arthroplasty successfully performed with preservation of posterior cruciate ligament as a functioning biologic stabilizer of the prosthetic knee joint.[24] Dorr and associates analysed the gait of 11 patients with bilateral paired posterior cruciate sacrificing and cruciate retaining arthroplasties. They found the sacrificed cruciate is less efficient when walking on level ground and in climbing stairs[25].

Soudry and Walker and colleagues examined the effect of total joint design on tibiofemoral contact conditions. They found that a compromise situation existed by which, when the posterior cruciate ligament was retained shear and rocking force transmitted to the components was less than when the posterior cruciate ligament was sacrificed[23]. There is no question that the total knee replacement is a highly successful procedure with the vast majority of patients having successful results to 10 years and beyond. Long term studies of modern forms of both cruciate retaining and cruciate sacrificing designs have shown equivalent survivorship of prostheses.[26,27,28]

Ritter and associates in 1994 have published their 10 to 18 year survival analysis of the posterior cruciate retaining posterior cruciate condylar total knee replacements.[29]

Kaplan Meier survival analysis revealed a 96.8%survival at 12 years. Stern and Insall examined 229 total knee arthroplasties using an all polyethylene posterior stabilized tibial component and found a survival rate of 94%at 13 years.[28]

In 1993 Ranawat and colleagues reported a 94% 15 year survival of 112 posterior cruciate ligament sacrificed total condylar prostheses.[29] Rand evaluated a series of posterior cruciate sparing arthroplasties and found a 96%survival at 10 year.[30]

Skinner and associates assessed joint position sense of the knee in 29 subjects and found that proprioception deteriorated with increasing age.[31] In 1993 Warren and associates examined proprioception after total knee joint arthroplasty in particular the role of prosthetic design on proprioception.

They found that a posterior cruciate ligament retaining prostheses conferred a statistically significant greater improvement in proprioception than a posterior cruciate sacrificing design. That is due to the effective recreation of the joint height.[32]

ANATOMY

The structures about the knee into 3 broad categories

1. Osseous structures
2. Extra articular structures
3. Intra articular structures

OSSEOUS STRUCTURES

Consists of three components

1. The patella
2. The distal femoral condyle
3. The proximal tibial condyle

Knee is called a hinge joint, but actually, it is more complicated than that, because in addition to flexion and extension it has rotatory component.

The femoral condyles are two rounded prominences that are eccentrically curved. Anteriorly the condyles are flattened, which creates larger surface area for contact and weight transmission. The groove anteriorly between the condyles is the patello-femoral groove or the trochlea, which accepts the patella. Posteriorly the condyles are separated by the intercondylar notch. The articular surface of medial condyle is longer than that of the lateral condyle, but the lateral condyle is wider. The long axis of the lateral condyle is oriented along the sagittal plane whereas the medial condyle is usually at about 22 degrees to the sagittal plane.

The expanded proximal part of the tibia forms the condyles or plateaus that articulate with the femoral condyles. Intercondylar eminence separates medial and lateral intercondylar tubercles. Anterior and posterior to the eminence are the areas that serve as attachment sites for cruciate ligaments and the menisci.

The articular surfaces of the knee are not congruent. On the medial side, the femur meets the tibia like a wheel on a flat surface, whereas on the lateral side, it is like a wheel on a dome. Necessary stability was provided by the ligaments and other soft tissue structures about the knee.

The patella is a triangular shaped sesamoid bone that is wider proximally than distally. The articular surface of the patella is divided by a vertical ridge, creating a smaller medial and larger lateral articular facet or surface. With the knee in extension, the patella slides above the superior articular margin of femoral trochlea. In extension, the distal portion of the lateral patellar articular facet articulates with the lateral femoral condyle, but the medial facet articulates with medial femoral condyle only in complete flexion.

EXTRA ARTICULAR STRUCTURES

The important extra-articular structures supporting and influencing the function of the joint are the synovium, the capsule, collateral ligaments and the musculo-tendinous units that span the joint. These are

- The **quadriceps mechanism** – formed by four components inserting on the proximal pole of patella as a triangular tendon.

- The **gastronemius** – the most powerful calf muscle, spans the posterior aspect of the knee in intimate relationship to the capsule and inserts on to the femoral condyles

- The **pes anserinus** – the conjoined insertion of sartorius, gracilis and semitendinosus along the proximal medial aspect of tibia. These primary flexors of the knee also have a secondary internal rotation action on tibia. They protect the knee from rotary as well as valgus stresses.

- **Bicepsfemoris** inserts into the lateral tibia, fibular head and posterolateral capsular structures. It is a strong external rotator of tibia. It also provides varus and rotatory stability.

- The **iliotibial tract** is inserted on the lateral epicondyle of femur and extends on to the Gerdy's tubercle on the tibia.

- The **popliteus** with its tripartite origin supports rotary stability to the femur on the tibia and aids the posterior cruciate ligament in preventing forward dislocation of femur on tibia.

- The **semimembranosus** muscle is important as a stabilizing structure around the posterior and posteromedial aspects of the knee.

The principal extra articular static stabilizing structures are the capsule and collateral ligaments.

The capsular structure, along with the medial and lateral extensor expansions of the powerful quadriceps musculature, are the principal stabilizing structures anterior to the transverse axis of the joint. Collateral ligaments and the medial and lateral hamstring muscles, as well as by the popliteus muscle and the iliotibial band reinforces the capsule posterior to the transverse axis.

The medial collateral ligament is a strong well – delineated structure superficial to the medial capsule originating on the medial epicondyle and inserted 7 to 10 cm below the joint line on the posterior half of the medial surface of the tibial metaphysis deep to pes anserinus. It provides the principal stability against the valgus stress.

The fibular collateral ligament attaches to the lateral femoral condyle proximally and the fibular head distally. It is mainly a stabilizer against varus stress.

INTRAARTICULAR STRUCTURES

The principal intraarticular structures of importance are the medial and lateral menisci and the anterior and posterior cruciate ligaments.

Numerous functions have been attributed to the menisci, which includes shock absorption, deepening of joint and stabilization of the joint.

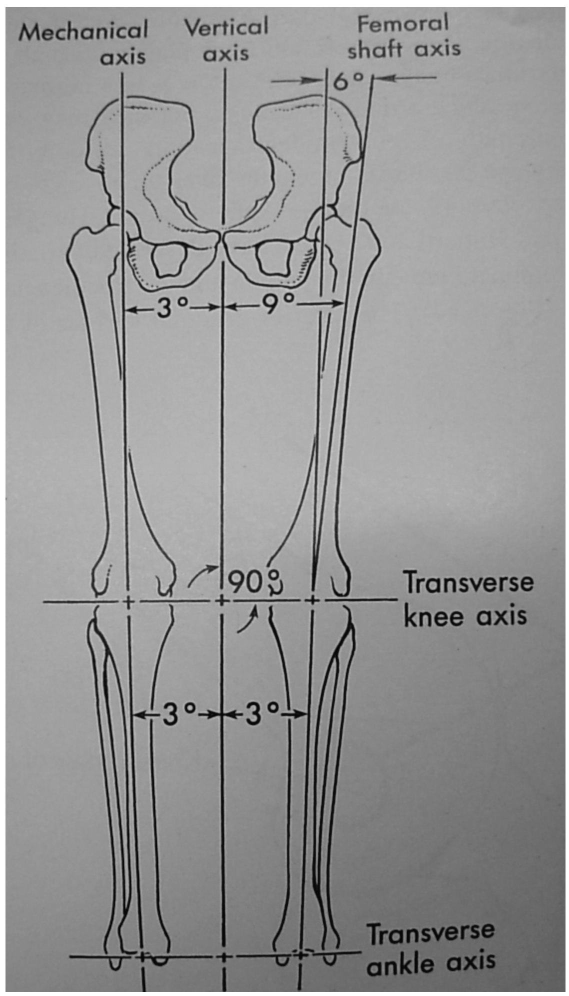
The cruciate ligaments function as stabilizers of the joint and axes around which rotary motion, both normal and abnormal occurs. They resist forward and backward motion of tibia on femur.

Anterior cruciate ligament is a two bundle ligament, consisting of small anteromedial and large posterolateral bundle. The anterior cruciate ligament originates from the posterior part of the medial surface of the lateral femoral condyle within the condylar notch and inserts on tibial plateau medial to the insertion of the anterior horn of lateral meniscus.

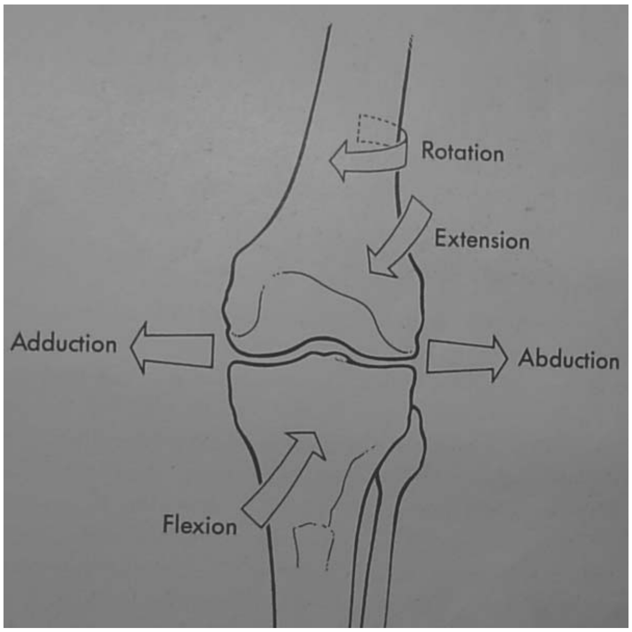
The posterior cruciate ligament is composed of two major parts, a large anterior portion that forms the bulk of the ligament and a smaller posterior portion that runs obliquely to the back of the tibia. The posterior cruciate ligament attaches proximally to the posterior part of the lateral surface of the medial condyle. The tibial attachment is in a depression behind and below the intraarticular portion of the tibia. It is larger and stronger than the anterior cruciate ligament.

BIOMECHANICS

The mechanical axis of the femur does not coincide with its anatomical axis, since a line traversing the center of the hip joint and the center of the knee forms an angle of 6 to 9 degrees with the axis of the shaft of the femur. The knee possesses features characteristic of both ginglymus and a trochoid articulation.



Movement of the knee joint can be classified as having 6 degrees of freedom: 3 translations (including anterior / posterior, medial / lateral, and inferior / superior) and 3 rotations (including flexion / extension, internal / external, and abduction / adduction). Movements of the knee joint are determined by the shape of the articulating surfaces of the tibia and femur and the orientation of the 4 major ligaments of the knee joint, including the anterior and posterior cruciate ligaments and the medial and lateral collateral ligaments as a 4-bar linkage system.



Knee flexion / extension involves a combination of rolling and sliding called femoral rollback, which is an ingenious way of allowing increased ranges of flexion. Because of asymmetry between the lateral and medial femoral condyles, the lateral condyle rolls a greater distance than the medial condyle during 20 degrees of knee flexion. This causes coupled external rotation of the tibia, which has been described as the screw-home mechanism of the knee that locks the knee into extension.

The primary function of the medial collateral ligament is to restrain valgus rotation of the knee joint, with its secondary function being control of external rotation. The lateral collateral ligament restrains varus rotation and resists internal rotation.

The primary function of the anterior cruciate ligament (ACL) is to resist anterior displacement of the tibia on the femur when the knee is flexed and control the screw-home mechanism of the tibia in terminal extension of the knee. A secondary function of the ACL is to resist varus or valgus rotation of the tibia, especially in the absence of the collateral ligament. The ACL also resists internal rotation of the tibia.

The main function of the posterior cruciate ligament (PCL) is to allow femoral rollback in flexion and resist posterior translation of the tibia relative to the femur. The PCL also controls external rotation of the tibia with increasing knee flexion. Retention of the PCL in total knee replacement has been shown biomechanically to provide normal kinematic rollback of the femur on the tibia. This is important for improving the lever arm of the quadriceps mechanism with flexion of the knee.

Movement of the patellofemoral joint can be characterized as gliding and sliding. During flexion of the knee, the patella moves distally on the femur. This movement is governed by the attachments of the patellofemoral joint to the quadriceps tendon, ligamentum patellae, and the anterior aspects of the femoral condyles. The muscles and ligaments of the patellofemoral joint are responsible for producing extension of the knee. The patella acts as a pulley in transmitting the force developed by the quadriceps muscles to the femur and the patellar ligament. It also increases the mechanical advantage of the quadriceps muscle relative to the instant center of rotation of the knee.

The mechanical axis of the lower limb is an imaginary line through which the weight of the body passes. It runs from the center of the hip to the center of the ankle through the middle of the knee. This is altered in the presence of deformity and must be reconstituted at surgery, which allows normalization of gait and protects the prosthesis from eccentric loading and early failure.

ROLE OF POSTERIOR CRUCIATE LIGAMENT IN TOTAL KNEE ARTHROPLASTY

Advantages of posterior cruciate ligament:

The first argument in favor of PCL retention is a greater potential range of motion with effective femoral roll-back and a relatively flat tibial articular surface. It functions as a restraint to translational displacement of the knee. In PCL substituting designs, displacement must be resisted by the prosthetic articular geometry, with the resultant stress borne by the prosthetic construct and ultimately transferred to the bone-cement interface.

Individuals with PCL retaining prostheses have a more symmetrical gait, especially during stair climbing, than do individuals with either PCL-sacrificing or PCL-substituting designs. Less bone resection is required on the femoral side of the arthroplasty because no cut out is required for a cam mechanism. The relationship of the patella to the joint line is altered less with PCL-retaining prostheses that improves function of the patellofemoral joint. PCL increases the mechanical advantage of quadriceps moment arm.

If PCL is sacrificed, then a cam is necessary to act as a constraint. This construct has to resist the translational stress. This stress would be transmitted to the prosthesis-bone interface and could ultimately result in loosening of the bone-prosthesis interface.[34-42]

DISADVANTAGES

If PCL is diseased with various forms of arthritis and contractures and thus is difficult to balance reproducibly and thus functions sub optimally. It is difficult to get the PCL tension right. If it is too loose, it will not help with femoral roll-back. A PCL that is too tight in flexion can limit the extent of flexion attained postoperatively, as well as lead to excessive femoral roll-back. If roll-back is excessive, there is too much of antero-posterior transfer of tibio-femoral contact area. This could result in excessive cyclical compression and tension loading. This could create a see-saw effect on the tibial component and eventual loosening.

In a knee with fixed flexion deformity, fixed varus or valgus deformity of more than 15 degrees correction requires release.[34-42] To retain PCL means choosing a less conforming tibial platform to allow for femoral roll-back. As we know this means risking higher contact stress and early HDP wear. Paradoxical anterior tibial translation in flexion in a poorly functioning posterior cruciate retaining knee may lead to early polyethylene wear.

BIOMATERIAL

WEAR

Most total knee replacements articulate a metal femoral component on a tibial component made of ultra high molecular weight polyethylene. It was originally thought that polyethylene worked well in total knee replacements, although damage was seen more than in total hip replacements.

Insall reviewing the result of total condylar prosthesis at 5 to 9 years follow up found no cases in which the femoral component had significantly perforated the tibial tray (Insall et al 1983). Bryan and Rand found a polyethylene wear rate of only 0.14 % in 5642 patients (Bryan & Rand 1982). The main cause of failure of the original knee replacement design was loosening of the tibial components. As fixation of the tibial component improved, the problems of polyethylene wear were increasingly recognized (Engh et al 1992). They reported failures when the polyethylene was thin or the articulation was less congruent (Marmor 1979, Goodfellow 1992).[33]

The initial investigators may have underestimated the problem because of the conforming designs and large thickness of the polyethylene used in the early prostheses.

Wear is proportional to load times the sliding distance and the wear rate of ultrahigh molecular weight polyethylene is inversely proportional to the molecular weight of this plastic. The aim of prosthetic design in respect to reducing wear is to minimize the contact stresses on the plastic, which, in turn minimizes deformation and wear. The ideal components in this respect would have complete conformity. This however is not possible if the needs of anterior posterior and rotational laxity are taken into account. In most condylar replacements, it can only occur at full extension. When the knee is flexed, the posterior femoral surface comes into contact with the tibial component which has a smaller radius of curvature. This leads to point contact and increased stresses. Newer designs of meniscal bearing prostheses may overcome this problem.

The severity of plastic wear from designs of different geometry can be obtained from retrieval studies. Three types of wear can occur

1. Adhesive – occurring at local contact points, this generates small particles 0.1 -10 μm as well as thin sheets 10 μm in width.

2. Abrasive - caused by cutting of the plastic surface by harder particles. This can be either two bodies or three-body abrasion.

3. Delamination – this is caused by fatigue phenomenon in which high surface tension leads to propagation of cracks and loss of surface material to a depth of a few millimeters.

ABRASIVE \ ADHESIVE WEAR

Each gait cycle produces compressive stresses at right angles to the tibial surface of the polyethylene and tensile stresses at the edge. The contact area may move as much as 15mm with each gait cycle. Thus during each gait cycle a point on the surface may be subject to a cyclic stress sequence of four peaks of tensile stress separated by periods of either no stress or of compressive stress (Bartel et al 1986).

On many tibial components especially of low or moderate conformity regions of wear appears which are well defined and appear as shiny areas with superimposed scratches. This appearance is caused by both adhesive and abrasive wear. The wear area is depressed below the surrounding surface. This may initially be seen to be beneficial but the yield occurs in the first few months after which surface wear proceeds steadily with time. When the plastic is incased in a metal tray the stresses within the plastic may be elevated due to rigidity of the metal. This effect is a greater on thinner plastic, which should consequently be greater than 6 mm in thickness.

Experimental evidence suggests that surface wear can be reduced by using femoral components that are harder than cobalt chrome example aluminium oxide or zirconium oxide. This allows less scratching of the femoral component surface with leads to a consequent decrease in abrasive wear of the ultrahigh molecular weight polyethylene tray.

DELAMINATION

The most severe type of wear is Delamination. This type of wear is time dependent. Delamination does not seem to occur until the prostheses has been in situ for longer than 8 years (Landy & Walker 1988). After this time, its occurrence increases rapidly. Therefore, it would be wrong to judge the wear resistance of a particular design on relatively short follows up because Delamination wear may occur rapidly after a certain period.

The earliest sign is blister formation, indicating subsurface cracking. Typically, sections through a delaminated area show horizontally oriented cracks curving towards the surface and then cracking upward towards the surface. Polarized light microscopy shows that high residual shear stresses occur some depth below the surface of the polyethylene component (usually 1-2 mm)

Delamination has also been shown to occur in the intercondylar notch region where there was evidence of resisting internal and external rotation. In order for subsurface stresses to produce, delamination there needs to be a site for initiation of cracks. This site is probably intergranular defects where inadequate bonding has taken place between the polyethylene granules. Retrieval studies have demonstrated that polyethylene without defects rarely found to have cracks or Delamination wear. Hence, it is extremely important that the processing and the quality control ensure a defect free polyethylene is used in knee replacement.

Hot pressing, by which the surface is compressed under high temperature to produce the surface shape, produces a level below the surface where the material properties abruptly change, resulting in an increased propensity for subsurface cracking. Recent work also indicates that oxidation of the polyethylene results in decreased molecular weight and material embrittlement which is likely to increase wear. Sterilization by Gama irradiation may increase this predisposition to oxidation, as may the longer duration's shelf storing prior to implantation, thus leading to more brittle ultrahigh molecular weight polyethylene.

As well as causing alteration in the mechanical properties of the implant, wear can have a biological effect. Polyethylene wear debris has increasingly been implicated as the cause of osteolysis in toal hip arthroplasty and it is reasonable to assume the same situation will arise in the case of knee replacements. Jones et al demonstrated a wide distribution of HDP wear particles in knee replacement patients (Jones et al 1992). Large fragments of HDP (130 μm) are too large to be ingested by macrophages and therefore produce foreign body reaction in which the large particles are surrounded by multinucleated macrophages and incite an inflammatory response. Small wear particles can also induce osteolysis due to a local cell mediated response (Kilgus et al 1992, Nolan & Bucknill 1992).

SURGICAL TECHNIQUE

Under epidural / spinal anaesthesia, with tourniquet control, arthrotomy done through midline medial para Patellar approach and Patella everted laterally. Both menisci and anterior cruciate ligaments excised.

Tibial resection made with an external alignment jig. Femoral resection made with an intramedulary alignment jig. Posterior cruciate ligament assessed after bony cuts made in tibia and femur.

LIGAMENT BALANCING

Ligament balancing performed, ensuring equal flexion and extension gaps. Graduated bocks utilized in this process and appropriate ligament release done to achieve balance of soft tissues with equal flexion and extension gaps.[36&52] Following this step, chamfer cuts on the distal femur are completed. Posterior osteophytes removed subsequently.

Trial tibial and femoral components inserted; thickness of the poly calculated after assessing the mediolateral stability.

The knee taken through range of movement to asses the posterior cruciate ligament tension, rotational position of the tibial component and finally patellar tracking. In cruciate retaining cases, congruent insert was used. In cruciate sacrificing cases ultra congruent poly used. Components fixed after cementation. Tourniquet released and haemostasis secured.

POST OPERATIVE PROTOCOL

DT removed after 48 hours.

Intravenous antibiotics given for five days

Quadriceps exercises started on second postoperative day

Weight bearing and Knee mobilization started on 2^{nd} day. Walking with knee brace till Quadriceps power is 3.

MATERIALS AND METHODS

INCLUSION CRITERIA

This is a prospective study, done in Kilpauk Medical College from June 2004 to November 2007. Who have undergone total knee arthroplasty for various indications, which includes varus as well as valgus knee.

During this study period 26 knees were replaced in 18 patients. All patients were followed at 3weeks, 6weeks, 12weeks, thereafter every 6 months.

EXCLUSION CRITERIA

Patients who did not turn up for follow-up and patients who had prior patellectomy were excluded.

AGE GROUP

Range	47years to 77years
Mean	60.11 years

SEX RATIO

Total	18
Male	03
Female	15

INDICATION

DISEASE	Number
Osteoarthritis	18
Rheumatoid arthritis	06
Posttraumatic arthritis	02

SIDE

SIDE	Number
Right	05
Left	05
Bilateral	08

Type of Deformity

Deformity	Number
Varus	20
valgus	06

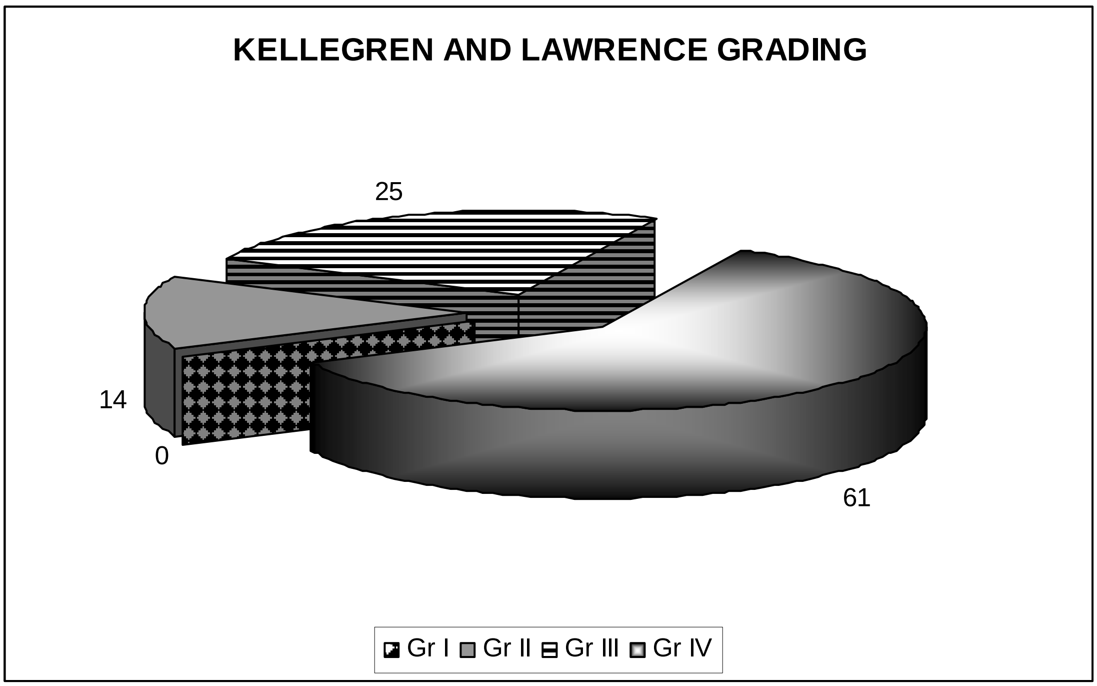
Preoperatively height and weight of the patients recorded. Scoring system formulated by the American knee society used to evaluate the patients before and after surgery. Both knee scores and functional scores calculated with each mounting to a total of 100 points.[43]

Preoperative weight bearing radiograph taken to all patients who underwent knee replacement surgery. Radiological grading system[44] as advocated by Kellegren and Lawrence used to evaluate the severity of arthritis and graded from I to IV as follows.

Grade		**Definition**
I	Doubtful	Minute osteophytes, doubtful significance
II	Mild	Definite osteophytes, unimpaired joint space
III	Moderate	Moderate diminution of joint space
IV	Severe	Joint space greatly impaired with sclerosis of subchondral bone

KL GRADING

The severity of the arthritis was assessed with the Kellegren and Lawrence scoring system which revealed that 61% (n=16) of our patient had grade IV arthritis at presentation.



All 18 cases were performed by different surgeons at various periods of time during the study period. Tourniquet routinely used in all cases. Posterior cruciate retained in 14 knees and sacrificed in 12 knees. In retained cases, congruent poly used as insert and in sacrificed cases, ultra congruent poly used.

Implant design	Number
Congruent poly insert	14
Ultracongruent poly insert	12

DVT prophylaxis not given to any of our patients

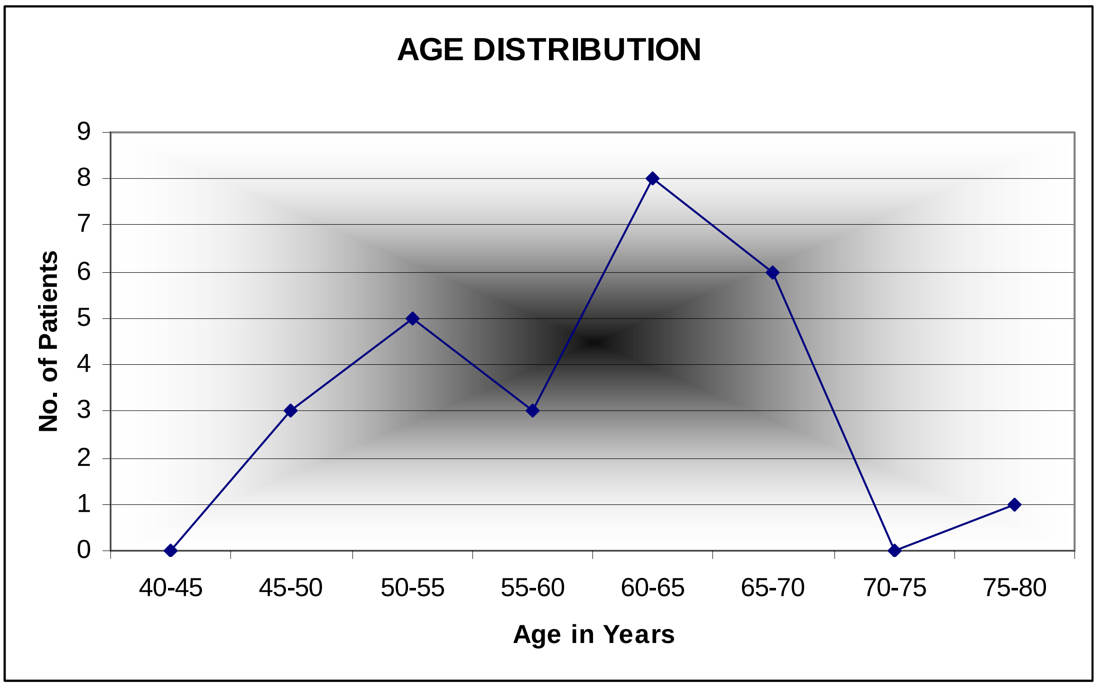
Standard postoperative protocol followed as advised by the American knee society. Patients discharged after suture removal on the 12th postoperative day.

Regular follow up done at 3 weeks, 6weeks, 12weeks and then every 6months. Post operatively patients functional outcome studied using knee society scores.

RESULTS

Age Distribution

The age of the patients who underwent total knee arthroplasty in our series ranged from 47 to 77 years; average was 60.11 years. More than 50% of the patients belong to sixth decade.



Height

The range in our series was from 150cms to 174cms. The mean was 158.11cms.

Weight

The weight of the patients ranges from 48kgs to 80kgs. The average weight was 60.03kgs.

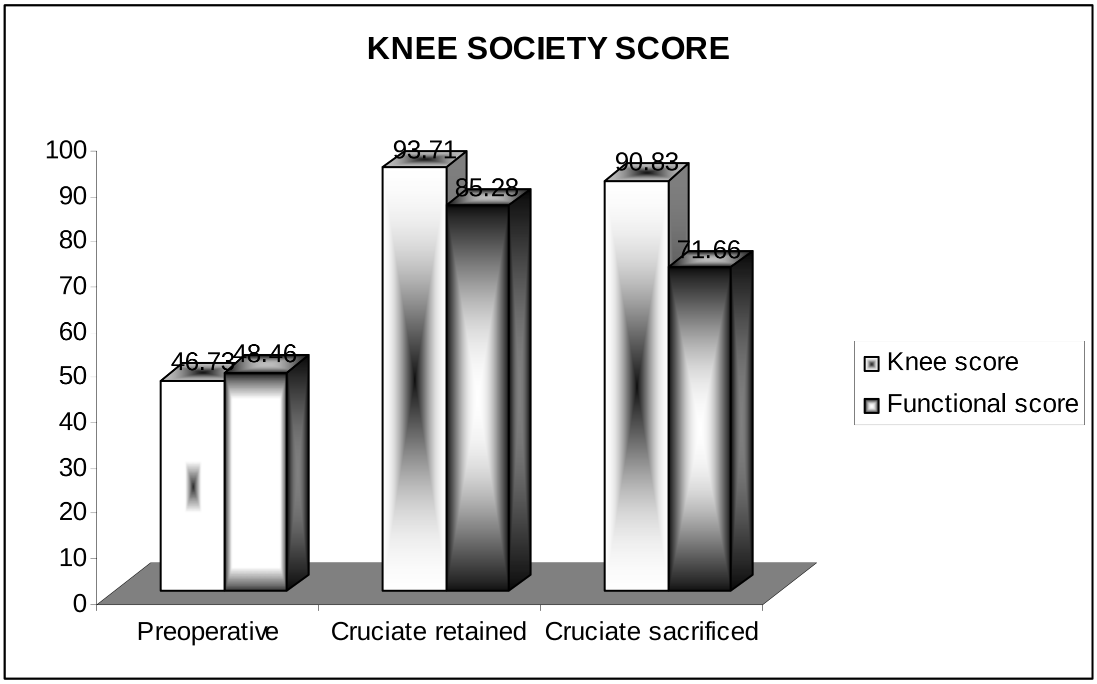
KNEE SOCIETY SCORE

All patients evaluated by scoring system proposed by The American Knee society.

The average preoperative knee society score was 46.73

The average preoperative functional score was 48.46

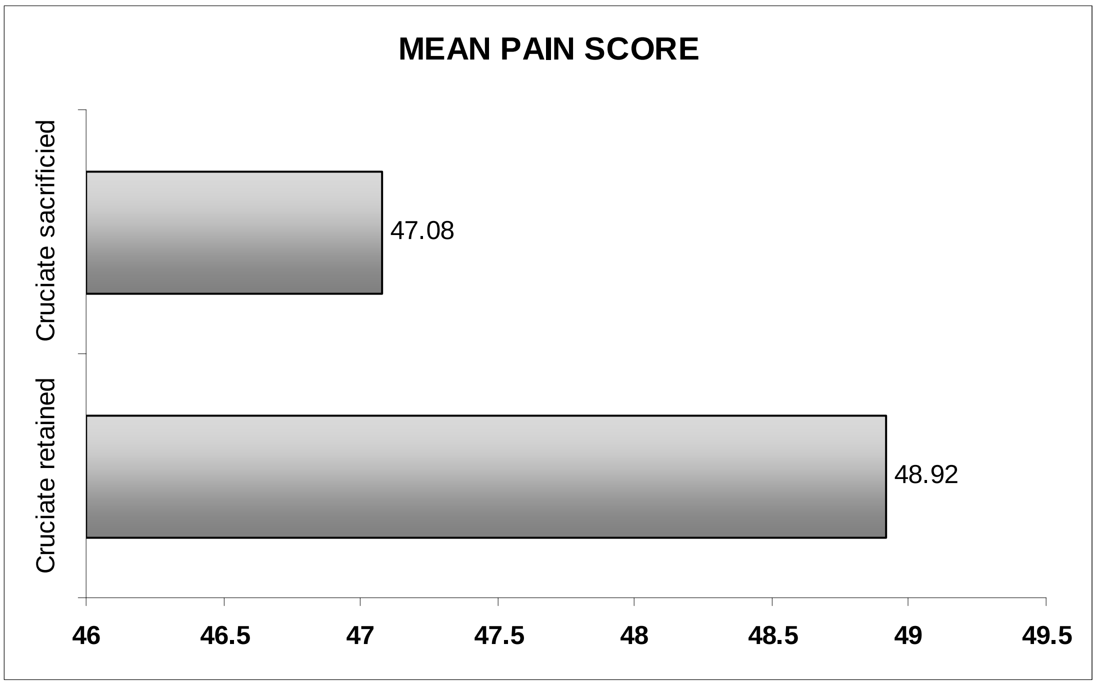
		Knee Score	Functional Score
Preoperative		46.73	48.46
Post operative	**Cruciate retained**	93.71	85.28
	Cruciate sacrificed	90.83	71.66



Of the 20 patients entered into the study, 18 (26 total knee replacements) patients were available for review. Their mean age was 60 years. Total knee arthroplasty was performed on 18 knees for osteoarthritis and 4 for rheumatoid arthritis and 2 for posttraumatic arthritis. 20 varus and 6 valgus knees .Two patients lost follow-up.

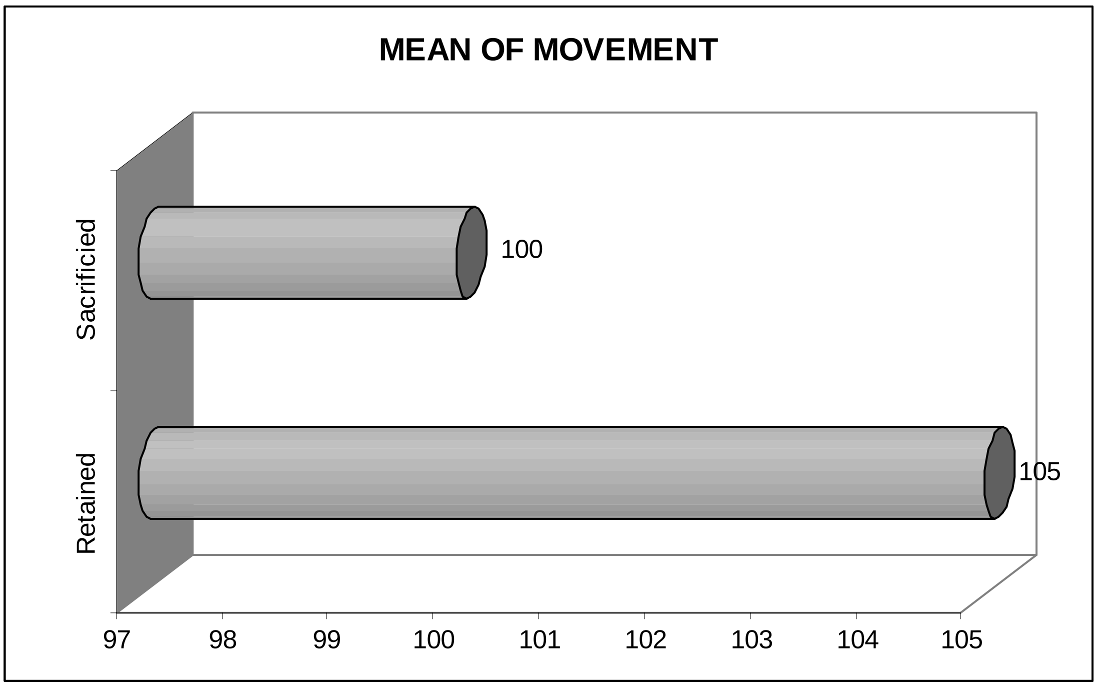
The mean pain score , range of movement , knee score , function score between the cruciate retained and the sacrificed groups shows that mean pain score for the retained group was 48.92 and 47.08 for the sacrificed group.

Group	Mean pain score
Cruciate retained	48.92
Cruciate sacrificed	47.08



The range of movement for the retained group was 105 degrees and 100 degrees in sacrificed group.

Group	Mean of movement
Retained	105 degrees
Sacrificed	100 degrees

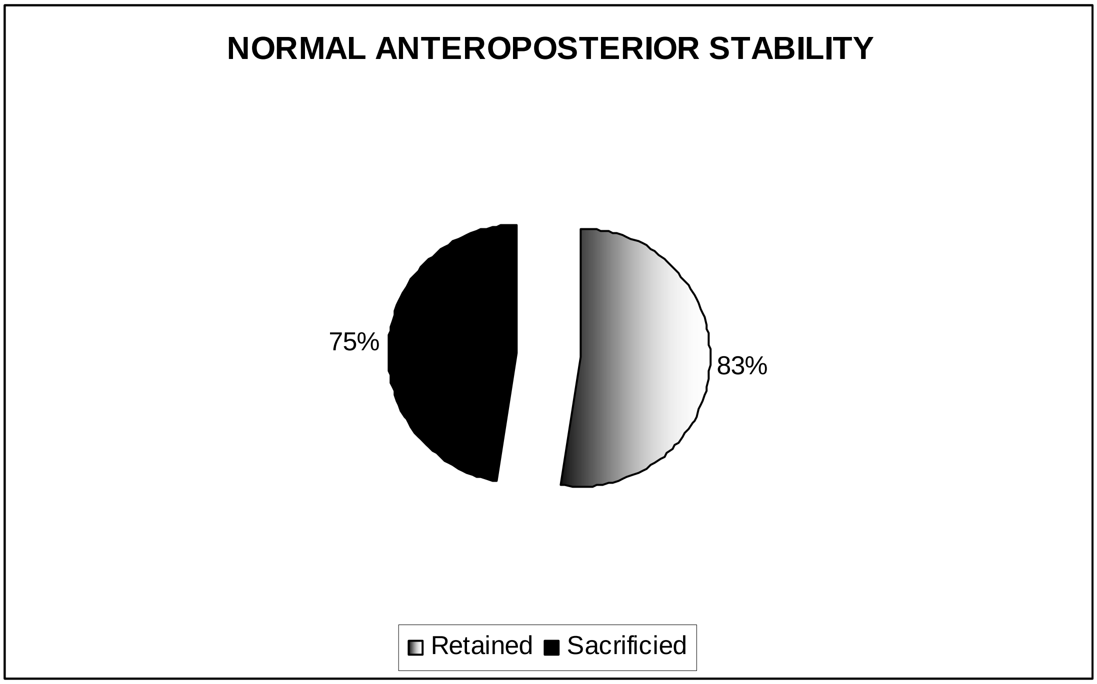


Mean knee society score for retained group is 94.07 and 92.08 for sacrificed group.

Group	Mean knee society score
Retained	93.71
Sacrificed	90.83

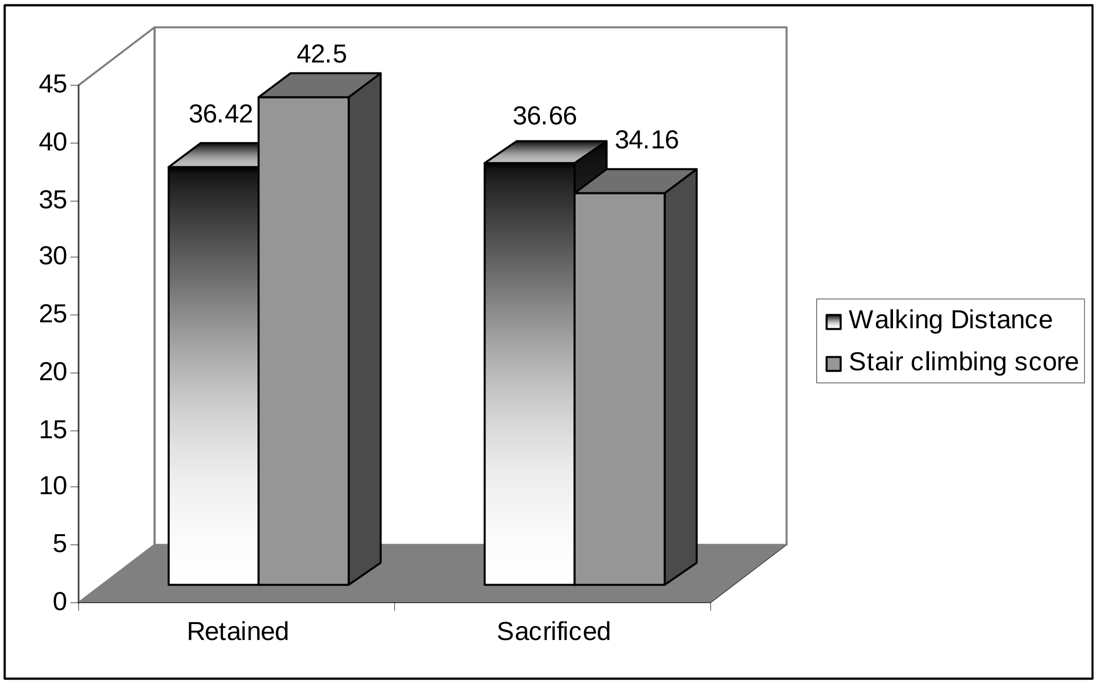
Stability assessed in both the anteroposterior and mediolateral planes. The cruciate retained knees were more stable with 83% (16 cases) having less than 5mm of anteroposterior tibial translation and 100% having less than 5 degree of tibial tilt in mediolateral plane. 75% (14 cases) of excised group had less than 5mm of tibial translation. This laxity not reflected in mediolateral planes.

Knee	Normal anteroposterior stability	Normal mediolateral stability
Retained	83%	100%
Sacrificed	75%	100%



The walking distance between the sacrificed and retained group does not show significant difference, but stair climbing and functional score favors cruciate retaining knee arthroplasty.

Group	**Walking distance**	**Stair climbing score**	**Function score**
Retained	36.42	42.5	85.28
Sacrificed	36.66	34.16	71.66



45
40
35
30
25
20
15
10
5
0
42.5
36.42
36.66
34.16
Retained
Sacrificed
Walking Distance
Stair climbing score

DISCUSSION

Total knee arthroplasty for arthritic patients in whom all the conservative measures are exhausted, is an excellent procedure if proper attention paid to the patient selection.

As total knee arthroplasty is a surface replacement within the existing soft tissue sleeve, it functions within normal anatomic and physiologic boundaries. Impaired functionality after total knee arthroplasty attributed to sequelae of the arthritic disease, the surgical trauma and the design of the prosthesis. Recent information on the outcome of minimally invasive procedures suggests the reduction of the surgical trauma offers early improvement and faster rehabilitation. This effect levels off after 3 months to a result similar to that in patients who had a standard exposure. This means factors other than the exposure and extensor mechanism violation are involved in the reduced functionality after total knee arthroplasty.

Various factors are associated with the onset and progression of osteoarthritis.[45-51] These include genetic factors, age, sex, obesity, occupation, abnormal loading of the joint in kneeling, squatting and cross-legged sitting.

The mean age of our patients who had osteoarthritis is lesser than the data available from the western population. The earlier onset of osteoarthritis in individuals with normal range of body mass index explained by the habit of kneeling, squatting, cross-legged sitting practiced by the population in this part of the world. Various studies have confirmed the abnormal loading of knee joint during heavy physical activity, particularly kneeling, squatting and cross-legged sitting.[45-51]

Eckstein et al in his study on the vivo cartilage deformation during different types of activity noted that the pattern of patellar cartilage deformation corresponds to the range of motion involved in a particular activity

Out of 18 patients 11 had complete obliteration of joint space at the time of presentation, due to lack of awareness about nature of the disease and about the availability of the various treatment modalities including surgery. Low socioeconomic status and illiteracy may be contributing factors for this.

Retention of posterior cruciate ligament in total knee arthroplasty, advocated as a way to transmit load through the ligament to the tibia, to encourage femoral component rollback to increase flexion, and to assist in maintaining the joint line. Retention of posterior cruciate ligament results in a central contact area of the femur on the tibia that helps to distribute load evenly on the tibial component. In our study flexion and standing view radiographs taken postoperatively for all patients. PCL retained cases exhibits femoral rollback when compared to the PCL sacrificed knees.

In 99% of the virgin arthritic knees requiring arthroplasty including rheumatoids posterior cruciate ligament was found to be intact.[53] The intact PCLmay have to sacrificed in rare instances. In the knee with severe angular deformity requiring an extensive release on the concave side of the deformity, the intact posterior cruciate ligament can act as a tether and hinder proper balancing of medial and lateral structures.[54] In our experience, this has occurred twice in the last 12 knees. Each knee has presented with angular deformity of 30 degrees and required extensive medial and lateral release.

We have used the scoring system as advocated by the American knee society. According to this system only three main parameters pain, stability, range of motion judged.

Flexion contracture, extension lag and misalignment dealt with as deductions. Thus, 100 points given to knee with no pain, 125 degrees of motion and less than 5mm of anteroposterior and 5 degrees of mediolateral instability.

Functional score considers walking distance and stair climbing with deductions for walking aids. The maximum functional score 100 is given to patients who can walk unlimited distance and go up and down stairs normally.

Although some advocate retaining the posterior cruciate ligament in all patients and others argue for posterior cruciate ligament sacrifice and substitution in all patients Laksin et al suggest a more appropriate approach in which implant design selection based on an individual's pathologic criteria.

In our study, posterior cruciate ligament sacrifice was done in patients who had severe end stage degenerative arthritis, valgus and varus deformities of more than 25 degrees, where surgical exposure is challenging and balancing soft tissue is difficult.

All 18 patients evaluated preoperatively and postoperatively using knee society score. Statistically no significant differences in the follow-up mean pain score and mean knee soc6iety score observed in both the cruciate retained and sacrificed groups. Anteroposterior and mediolateral instability does not show any significant differences in both the groups. Translation of the proximal tibia posteriorly in flexed knee is very well obvious radiologicaly in sacrificed group indicating posterior cruciate ligament's function as a restraint to translational displacement.

Significantly, greater improvement in flexion from preoperative to most recent follow-up assessment seen in patients in the posterior cruciate retaining group compared to the sacrificed group. This is due to femoral roll back defined as the posterior shift of the tibiofemoral contact areas well exhibited radiologicaly after flexing the knee. In addition, a significantly greater improvement in stair climbing and the mean functional score in cruciate retained arthroplasty groups.

Charles Engh has observed that before any technique is to be adopted or recommended there must be a minimum follow up of ten years.[55] Ours is a small series with maximum follow up of only two years, we can not draw any conclusion from our findings.

But the average age of our total knee arthroplasty patients is less when compared to Western literature, the need of revision will be more. Hence by preserving the posterior cruciate ligament and the bonestock the subsequent revision will be easier.

CONCLUSION

In our short term analysis of this comparative study good results were obtained in both posterior cruciate retaining Total Knee Arthroplasty and posterior cruciate sacrificing Total Knee Arthroplasty.

However, Posterior cruciate cruciate retaining Total Knee Arthroplasty had a marginally better outcome than the posterior cruciate sacrificing Total Knee Arthroplasty but it needs a long term analysis.

PROFORMA

Patient name:		Surgeon's Name:	
Age	Sex	IP No.	Pre-Op/Post-Op
Address			DOA: DOD: DOS:
Phone No.			Height:
Occupation			Weight:

KNEE SCORE

Pain	**50 (Maximum)**

Walking

None	35
Mind or occasional	30
Moderate	15
Severe	0

Stairs

None	15
Mild or occasional	10
Moderate	5
Severe	0

Range of motion	**25 (Maximum)**

5° = 1 point

Stability	**25 (Maximum)**
Medial / Lateral	
0-5 mm	15
5-10 mm	10
> 10 mm	5
Anterior / Posterior	
0-5 mm	10
5-10 mm	8
> 10 mm	5
Deductions	
Extension lag	
None	0
<4 degrees	-2
5-10 degrees	-5
>11 degrees	-10
Flexion Contracture	
< 5 degrees	0
6-10 degrees	-3
11-20 degrees	-5
> 20 degrees	-10
Malalignment	
5-10 degrees	0
(5° = -2 points)	
Pain at rest	
Mild	-5
Moderate	-10
Severe	-15

Symptomatic plus objective	0
<u>Knee Score</u>	**<u>100 (Maximum)</u>**

FUNCTIONAL SCORE

Walking

Unlimited	55
10-20 blocks	50
5-10 blocks	35
1-5 blocks	25
< block	15
Cannot	0

Stairs Up

Normal	15
Hand balance	12
Hands pull	5
Cannot or bizarre	0

Stairs Down

Normal	15
Hand balance	12
Hands pull	5
Cannot	0
Functional Deductions	
Cane	-2
Crutches	-10
Walker	-10

<u>Functional Score</u> **<u>100 (Maximum)</u>**

BIBILOGRAPHY

1. Merrill A. Ritter, Michael E.Berend, John B.Meding and Brain M.Crites. Long term followup of anatomic graduated components posterior cruciate retaining total knee replacement. *Clin Orthop.* 2001; 388, pp.51-57.

2. Scott RD, Volatile TB. Twelve years experience with posterior retaining total knee arthroplasty. *Clin Orthop* 1986; 205:100-7.

3. Insall JN.presidential address to the knee society. Choices and compromises in total knee arthroplasty. *Clin Orthop* 1998; 226: 43-8.

4. Kleinbert FA,Bryk E,Evangelista J, Scott WN, Vigorita VJ histological comparison of posterior cruciate ligaments from arthritic and age matched knee specimens . *J Arhtroplasty* 1996; 11: 726-31.

5. Freeman MAR, Insall N,Besser W, Walker PS, Hallel T. Excision of the cruciate ligaments in total knee replacement. *Clin Orthop* 1977; 126:209-12.

6. Matuda S, Whiteside LA, White SE, McCarthy DS. Knee kinematics of posterior cruciate ligament sacrificed total knee arthroplasty. *Clin Orthop* 1997; 341: 257-66.

7. Dennis DA, Komisteck RD, Hoff WA, Gabriel SM. In vivo knee kinematics derived using an inverse perspective technique. *Clin Orthop* 1996; 331: 107-17.

8. Scott RD, Thornhill TS. Posterior cruciate supplementing total knee replacement using conforming inserts and cruciate recession; effect on range of motion and radiolucent lines. *Clin Orthop* 1994; 309: 146-9.

9. R. Straw, S. Kulkarni, S. Attfield, T.J. Wilton posterior cruciate ligament at total knee replacement *J Bone Joint Surg* 2003; 85-B: 671-4.

10. Fergussen M: excision of knee joint : recovery with false joint and useful limb, *Med Times Gaz* 1: 601, 1861

11. Verneuil A: Resultats obtain for France par 1'operation d'esmarch: examen des causes d'insuccess et moyen d'yremedier, *Gas hebd med chir* 10: 97, 1863.

12. Smith-Peterson MN: Arthroplasty of hip : a new method, *J Bone Joint Surg* 31:269,1939.

13. Campell WC : interposition of vitallium plates in arthroplasties of the knee: preliminary report, *Am J Surg* XLVII: 639, 1940.

14. Shiers LGP: Hinge Arthroplasty of the knee, *J Bone Joint Surg* 47B: 586, 1985.

15. Gunsten FH: polycentric knee arthroplasty : Prosthetic simulation of normal knee movement, *J Bone Joint Surg* 53B: 272.1971.

16. Andriacchi TP, Galante JO. Retention of the posterior cruciate ligament in total knee arthroplasty. *J Arthroplasty.* 1988; 3 (suppl): 13.

17. Freeman MAR, Railton GT. Should the posterior cruciate ligament be retained or resected in condylar nonmeniscal knee arthroplasty. *J Arthroplasty* 1988; 3 (supp): S3.

18. Walker PS, Hajek JV. The load – bearing area in the knee joint. *J biomechanics.* 1972; 5: 581-589.

19. Walker PS, Rovick JS, Robertson DD. The effects of knee brace hinge design and placement on joint mechanics. *J Biomechanics.* 1988; 21: 965-974.

20. Thompson WO, Thaete LF,Fu FH, Dye SF. Tibial meniscal dynamics using three dimensional reconstruction of magnetic reconstruction images. *Am J Sports Med.* 1991; 19: 210-216.

21. EL Nahass B,Madson MM, Walker PS. Motion of the knee after condylar resurfacing –an in vivo study. *J Biomechanics.* 1991; 24: 1107-1117.

22. Schoemaker SC, Adams D,Daniel DM, Woo SL. quadriceps / anterior cruciate graft interaction. *Clin Orthop* 1993; 294: 379-390.

23. Soudry M, Walker PS, Reilly DT, Kurosawa H, Sledge CB. The effect of total knee replacement design on femorotibial contact conditions. *J Arthroplasty.* 1986; 1: 35-44.

24. Ritter MA, Faris PM,Keating EM. Posterior cruciate ligament balancing during total knee arthroplasty. *J Arthroplasty.* 1988; 3: 323-326.

25. Dorr LD, Ochsner JL, Gronley J, Perry J. functional comparison of posterior cruciate retained versus cruciate sacrificed total knee arthroplasty. *Clin Orthop.* 1988; 236: 36-43.

26. Ritter MA, Campell E, Faris PM, Keating EM. Long term survival analysis of the posterior cruciate condylar total knee arthroplasty. *J Arthroplasty.* 1989; 4: 293-296.

27. Vince KG, Insall JN, Kelly MA. The total condylar prosthesis. 10-12 year results of a cemented knee replacement. *JBJS* 1989; 71B: 793-797.

28. Stern SH, Insall JN. Posterior stabilized prosthesis: results after follow up of nine to twelve years. JBJS.1992; 74A: 980-986.

29. Ritter MA, Herbst SA, Keating EM, Faris PM, Meding JB. Long term survivorship analysis of a posterior cruciate retaining total condylar total knee arthroplasty. *Clin Orthop.*1994; 309: 136-145.

30. Ranawat CS, Flynn WF, Sadder S, Hansraj KK, Maynard MJ. Long term results of the total condylar knee arthroplasty: A 15 year survivorship study. *Clin Orthop.*1993; 286: 94-102.

31. Skinner HB, Barrack RL, Cook SD. Age related decline in proprioception. *Clin Orthop.* 1984; 184: 208-211.

32. Warren PJ, Olanlukum TK, Cobb AG, Bentley G. proprioception after knee arthroplasty- the influence of prosthetic design. *Clin Orthop.* 1993; 297: 182-187.

33. Insall et al (1976) – comparision of four models of total knee replacement prosthesis. *JBJS* (A) 58: 754-765.

34. Dorr LD. Technique of correction of varus deformity. *Technique Orthop.* 1988; 3: 77-85.

35. Dorr LD, Boiardo R. Technical considerations in total knee arthroplasty. *Clin Orthop.*1996; 205: 5-11.

36. Firestone TP, Krackow KA, Davis JD,Teeny SM, Hunger-ford DS. The management of fixed flexion contractures during total knee arthroplasty. *Clin Orthop.*1992; 284: 221-227.

37. Krackow KA, Jones MM, Teendy SM, Hungerford DS. Primary total knee arthroplasty in patients with fixed valgus deformity. *Clin Orthop.*1991; 273: 9-18.

38. Kumar PJ, Mcpherson EJ, Dorr LD, Wan Z, Baldwin K. Rehabilitation after total knee arthroplasty. *Clin Orthop.*1996; 331: 93-101.

39. Merritt J, Conaty P, Dorr LD. The effect of soft tissue releases on results of total knee replacement, total arthroplasty of the knee. Proceedings of the knee society, 1985-1986. Rockville, MD: *Aspen Publications*; 1987.

40. Oschner JL, Johnson WD. Flexion and extension gap measurements in total knee arthroplasty after sacrifice of the posterior cruciate ligament. *J of Southern Orthopedic Assoc.*1994; 3(4): 290-294.

41. Stern SH, Moeckel BH, Insall JN. Total knee arthroplasty in valgus knees. *Clin Orthop.*1991; 273: 5-8.

42. Teeny SM, Krackow KA, Hungerford DS, Jones M. primary total knee arthroplasty in patients with severe varus deformity. *Clin Orthop.* 1991; 273: 19-31.

43. John N. Insall, Lawrence D. Dorr, Richard D. Scott, and W. Norman Scott: Rationale of the knee society clinical rating system. *Clin Orthop.* 1989 Nov; (248): 13-14.

44. Kellgren JH, Lawrence JS. Radiological assessment of osteoarthrosis. *Ann Rheum Dis* 1957; 16: 494-502.

45. Jensen LK, Eenberg W: occupation as a risk factor for knee disorders. *Scand J Work Environ Health.* 1996 Jun; 22 (3): 165-75.

46. coggon D, Croft P, Kellingray S, Barrett D, McLaren M, Cooper C: occupational physical activities and osteoarthritis of the knee. *Arthritis Rheum.* 2000 Jul; 43 (7): 1443-9.

47. Jensen Lk. Knee-straining work activities, self reported knee disorders and radiographically determined knee oarthritis. *Scand J Work Environ Health.* 2005; 31 *Suppl* 2:68-74.

48. Manninen P, Heliovaara M,Riihimaki H,Suoma-Iainen O. physical work load and the risk of severe knee osteoarthritis. *Scand J Work Environ Health* 2002 Feb; 28(1): 25-32.

49. Kuster M, Wood GA, Sakurai S, Blatter G. stress on the biomechanical femoral patellar joint in downhill walking a biomechanical study. *Z Unfallchir Versicherungsmed.*1993; 86(3): 178-83

50. Kujala Um , Kettunen J Paananen H, Aalto T, Battie MC, Impivaara O, Videman T, Sarna S. knee osteoarthritis in former runners, soccer players, weight lifters, and shooters. *Arthritis Rheum.*1995 Apr; 38 (4): 539-46.

51. McMillan G, Nicholas L, osteoarthritis and meniscus disorders of the knee as occupational disease of Miners *Occup. Environ. Med.* 2005 Aug; 62 (8): 567-75.

52. Attfield SF, Wilton TJ, Pratt DJ, Sambatakakis A. Soft tissue balance and recovery of proprioception after total knee arthroplasty. *JBJS.* 1996; 78B: 540-545.

53. Scott, R.D. Duo Patellar total knee replacement: The Brigham experience. *Orthop. Clin. North Am.* 13:17, 1982.

54. Richard D Scott and Thomas B. volatile. Twelve years' experience with posterior cruciate – retaining total knee arthroplasty. *Clin Orthop* 1986; 205.

55. THR in patients 50 years and younger. James P. McAuley, Edward S, Szuszczcwicz, Anthony Young MSE and Charles A, Engh. Sr. Corr. No.418, Jan 2004, p.119-125.

TOURNIQUET

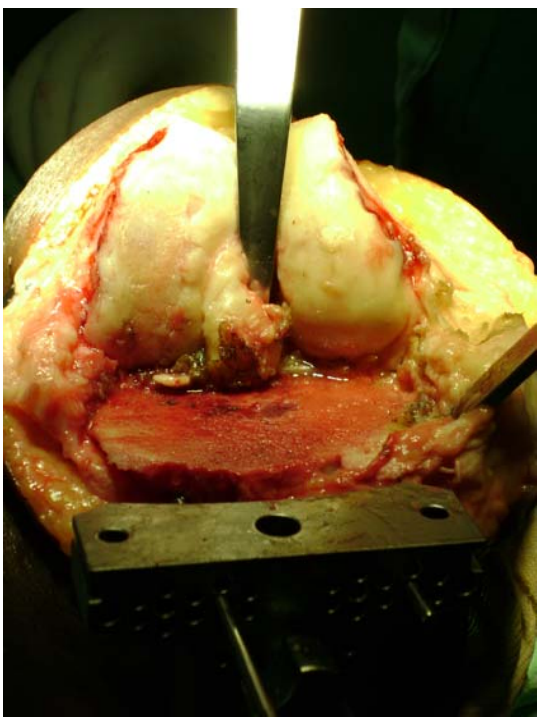
POSITION

PATELLA EVERTED LATERALLY

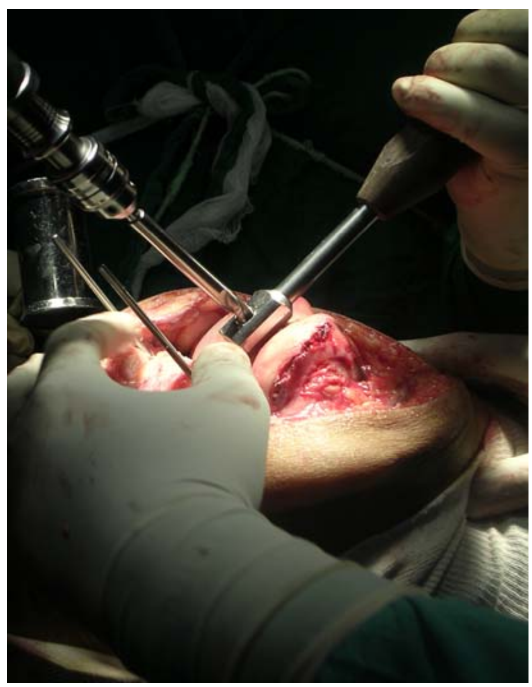
EXTRAMEDULLARY ALIGNMENT JIG FOR TIBIA

TIBIAL CUT MADE

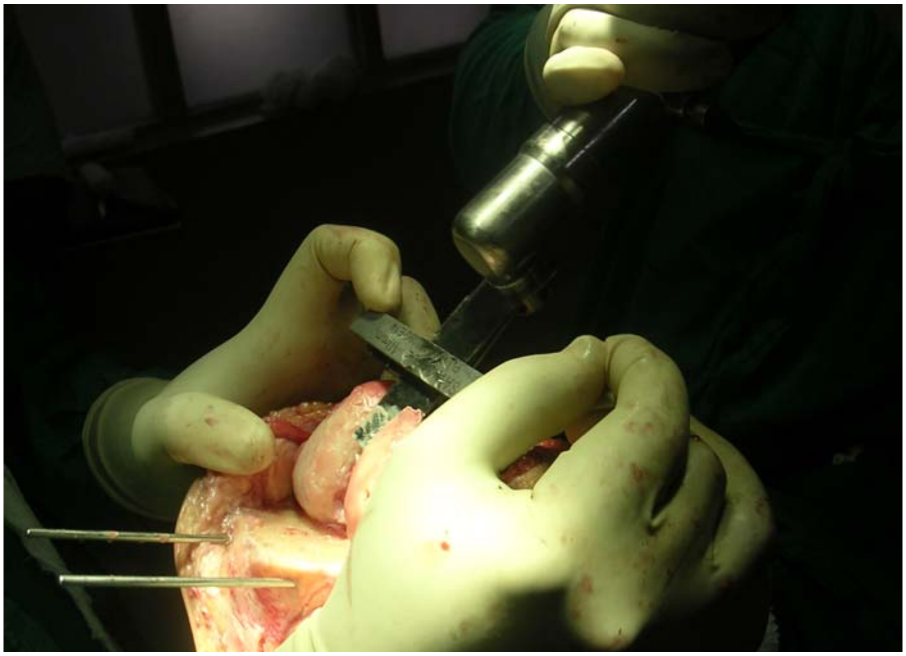
INTACT PCL AFTER TIBIAL CUT



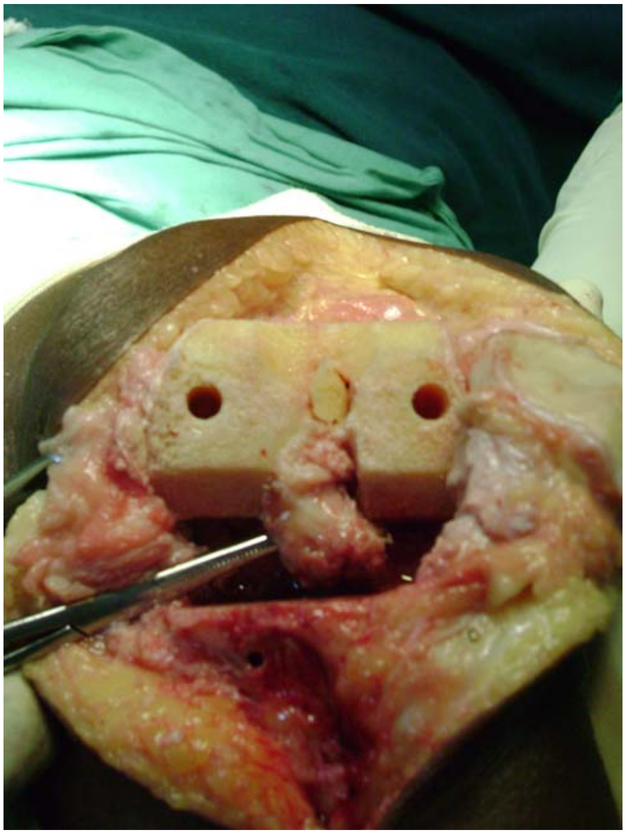
INTRAMEDULLARY ALIGNMENT MADE FOR FEMUR



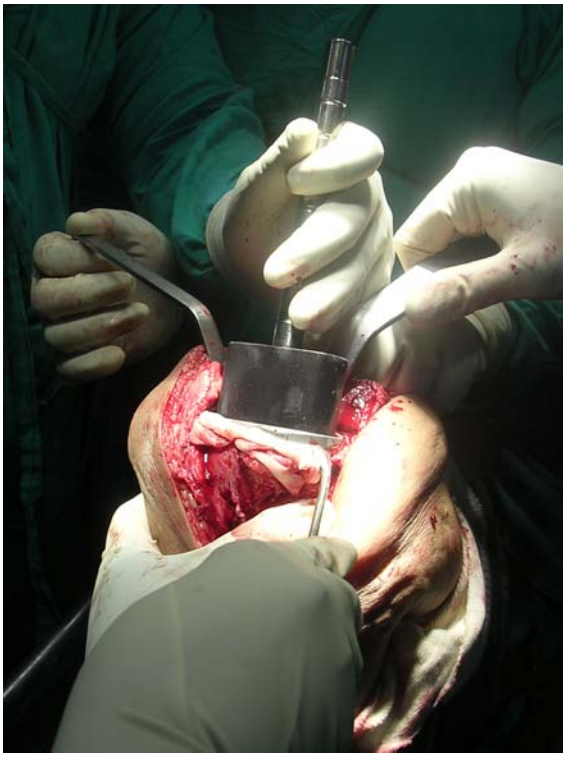
DISTAL CUT MADE



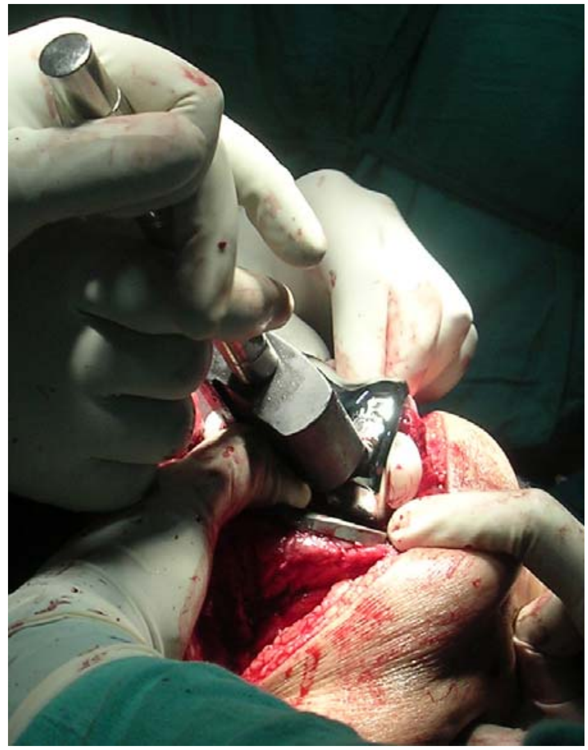
INTACT PCL AFTER FEMORAL AND TIBIAL CUTS



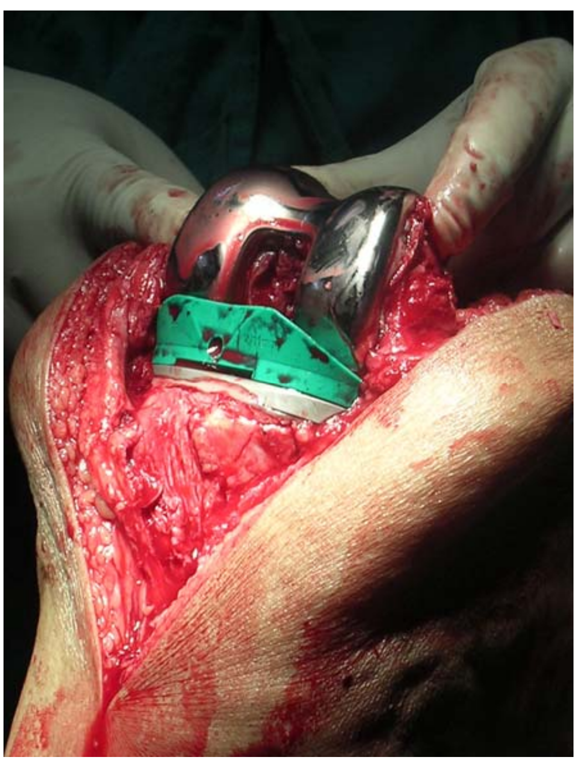
TIBIAL IMPLANTATION AFTER CEMENTATION



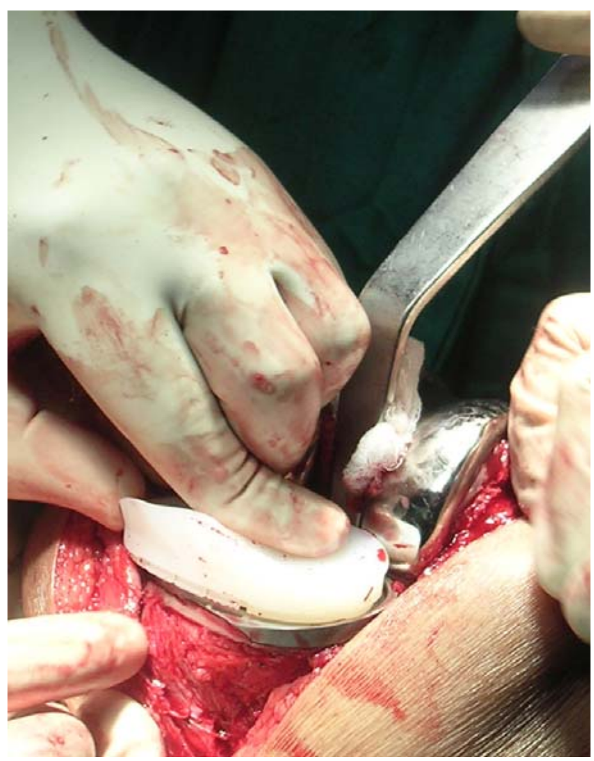
FEMORAL IMPLANTATION AFTER CEMENTATION



TRIAL POLY IN PLACE



POLY INSERT



CASE 1

(PCL RETAINED)

PREOP STANDING

PREOP X-RAY

POSTOP AP VIEW

POSTOP LATERAL VIEW

POSTOP FLEXION

POSTOP SLR

POSTOP FLEXION X-RAY

CASE 2

(PCL RETAINED)

PREOP AP VIEW

PREOP LATERAL VIEW

POSTOP AP VIEW

POSTOP LATERAL VIEW

POSTOP FLEXION VIEW

POSTOP EXTENSION

POSTOP FLEXION

POSTOP SLR

CASE 3

(PCL RETAINED)

PREOP AP VIEW

PREOP LATERAL VIEW

POSTOP FLEXION

IMM. POSTOP FLEXION

CASE 4

(PCL SACRIFICED)

PREOP STANDING

PREOP X-RAY

POSTOP AP VIEW

POSTOP LATERAL VIEW

POSTOP FLEXION

POSTOP EXTENSION

POSTOP SLR

POSTOP FLEXION

CASE 5

(PCL SACRIFICED)

POSTOP AP VIEW

POSTOP LATERAL

POSTOP FLEXION

POSTOP EXTENSION

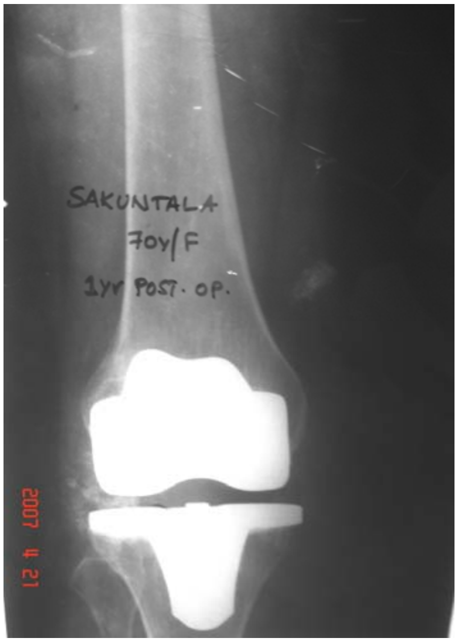
POSTOP FLEXION

POSTOP SLR

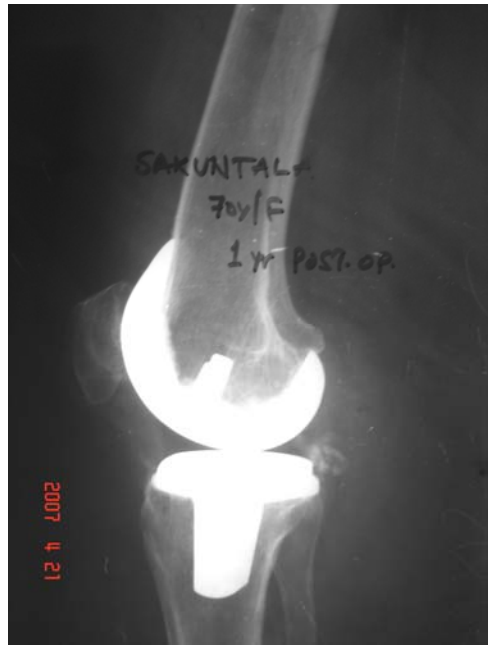
CASE 6

(PCL SACRIFICED)

POSTOP AP VIEW



POSTOP LATERAL VIEW



POSTOP FLEXION

POSTOP EXTENSION

POSTOP FLEXION

POSTOP SLR

Case 1

Lakshmi 50 year female presented with osteoarthritis right knee, with varus deformity of 15 degrees.

Posterior cruciate retaining arthroplasty done.

Preop range of movement - 70°

Postop range of movement - 120°

Preop ks - 54

Postop ks - 99

Case 2

Mrs. Jabakani 49 year female presented with posttraumatic arthritis left knee with varus deformity of 15 degrees.

Posterior cruciate retaining arthroplasty done.

Preop range of movement - 60°

Postop range of movement - 110°

Preop ks - 52

Postop ks - 97

Case 3

Mrs .menon 65 year female presented with osteoarthritis of right knee with varus deformity of 20 degres.

Preop range of movement - 60°

Postop range of movement - 100°

Preop ks - 55

Postop ks - 95

Case 4

Mrs. Gowri 65 years female presented with osteoarthritis of both knee with varus deformity on the left side of 30 degrees

Posterior cruciate sacrificing knee arthroplasty done

Preop range of movement - 80°

Postop range of movement - 100°

Preop ks - 55

Postop ks - 99

Case 5

Mrs. Banu 47 year female presented with rheumatoid knee with valgus deformity .bilateral total knee arthroplasty done.

Posterior cruciate sacrificing total knee arthroplasty done.

Preop range of movement - 60°

Postop range of movement - 100°

Preop ks - 48

Postop ks - 95

Case 6

Mrs. Sakuntala 77 year female presented with osteoarthritis right knee with varus deformity of 15 degrees.

Posterior cruciate sacrificing total knee arthroplasty done.

Preop range of movement - 60°

Postop range of movement - 100°

Preop ks - 48

Postop ks - 95

MASTER CHART

S.No.	Age	Sex	Ht	Wt	Indication	Side	Deformity in degrees	KL Score	Valgus Angle Degree	PCL	Range of Movement		PAIN		Preop KS	Postop KS	Preop FS	Post FS
											Preop	Postop	Preop	Postop				
1	50	F	154	48	OA	R	VS-15	3	6	R	70°	120°	40	50	54	99	58	90
2	49	F	154	48	PTA	L	VS-10	3	6	R	60°	110°	35	50	52	97	50	100
3	67	M	174	61	RA	R	VL-10	4	7	R	40°	110°	30	40	40	80	44	50
4	60	F	157	55	OA	L	VS-15	2	7	R	70°	100°	30	45	55	90	54	86
5	50	F	158	80	RA	R	VL-10	3	8	R	60°	100°	40	50	48	95	44	80
6	65	F	150	52	OA	R	VS-15	4	7	R	40°	100°	35	45	38	85	44	80
7	57	F	162	64	OA	L	VS-10	3	6	R	70°	100°	35	50	45	97	50	86
8	67	M	170	74	OA	R	VS-15	4	7	R	50°	110°	40	50	41	97	52	90
9	67	M	170	74	OA	L	VS-10	4	7	R	60°	110°	35	50	40	97	58	90
10	63	F	154	64	OA	R	VS-15	4	8	R	60°	110°	35	50	55	95	50	86
11	63	F	154	64	OA	L	VS-12	4	6	R	70°	100°	30	50	54	95	52	90
12	65	F	164	65	OA	R	VS-10	4	6	R	60°	100°	40	50	41	95	54	86
13	67	F	160	60	OA	R	VS-12	4	8	R	60°	100°	35	45	55	95	58	90
14	67	F	160	60	OA	L	VS-15	4	7	R	60°	100°	40	50	52	95	44	90
15	77	F	164	56	OA	R	VS-15	2	6	S	80°	100°	40	50	55	99	54	100
16	47	F	150	48	RA	R	VL-20	4	6	S	60°	100°	35	50	48	95	44	70
17	47	F	150	48	RA	L	VL-20	4	7	S	60°	120°	40	50	42	95	44	70
18	65	M	168	61	OA	R	VS-15	4	7	S	60°	100°	35	50	40	95	44	80
19	67	M	174	61	RA	L	VL-10	4	7	S	60°	100°	40	50	38	78	40	35

20	63	F	160	54	OA	R	VS-20	4	7	S	60°	100°	40	50	44	95	42	80
21	63	F	160	54	OA	L	VS-15	3	6	S	80°	90°	35	40	42	95	44	80
22	59	F	152	58	OA	R	VS-10	3	6	S	60°	100°	35	50	48	68	48	35
23	50	F	154	62	OA	L	VS-15	2	8	S	70°	100°	35	50	50	95	52	80
24	50	F	158	80	RA	L	VL-15	3	7	S	70°	90°	40	30	52	95	48	80
25	65	F	150	52	OA	L	VS-30	4	7	S	60°	100°	40	50	48	95	44	80
26	53	F	152	58	PTA	L	VS-30	4	7	S	60°	100°	30	50	38	85	44	70

OA - Osteoarthritis

RA - Rheumatoid arthritis

PTA - Post traumatic arthritis

VS - Varus

VL - Valgus

R - Posterior cruciate ligament retaining

S - Posterior cruciate ligament sacrificing

KS - Knee society score

FS - Functional score